Space Weather Technical Forecast

Issued on Friday 11 October 2024 at 02:24 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Initial G4-G5/Severe-Extreme Geomagnetic storms (Kp 8-9) easing though day 1 (11 Oct) to G1-G2/Minor-Moderate (Kp 5-6) by the end of the 11 Oct. Ongoing S1/Minor radiation storm, easing later 11 Oct. Likely R1-R2, slight chance of R3 flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has returned to Moderate levels, with an M3.0 from AR3842 peaking at 10/2230UTC. There are six numbered sunspot regions on the visible disc. The largest region on the disk is AR3848 in the northwest, losing it's delta magnetic complexity in recent hours. The next notable spot is the rapidly-growing AR3854 in the southeast, with a spreading tendency continuing. AR3852, just ahead of AR3854, has shown a gradual spreading trend, with north-south magnetic sheer. AR3849, in the southwest near centre disc, showed little change, while AR3850, to its immediate west is trending toward becoming a unipolar region. Previously active AR3842 has now completely rotated beyond the southwest limb.

No further Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The period was dominated by the arrival of the large CME from the X1.8 and filament eruption on 09 Oct. The solar wind measured at L1 by ACE and DSCOVR showed a rapid incline from 400-800+ km/s around 10/1445 UTC. With a further enhancement back to 800km/s around 10/2200 UTC. The solar wind density became largely above average after 10/1500 UTC peaking around 20 ppcc at 10/1700 UTC and again at 10/2200 UTC. The IMF Bt, became strong or very strong with an initial peak of 39nT at 10/1630 UTC, before a secondary peak of 45nT at 10/2200 UTC. The north-south component followed a similar trajectory with the almost entire period in negative (southward) directed orientation, with peaks of -44Bz observed at 10/2215 UTC. The phi angle was mostly positive (away from the Sun), but briefly negative (toward the Sun) later in the period.

The net result of the above solar wind measures was for Quiet to Active (Kp 2-4) geomagnetic activity followed by two G4/Severe (Kp8) periods and a G5/Extreme (Kp9) period to end the UTC day.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 has continued its response to the X1.8 flare on 09 October. 10MeV peaked at 1810pfu at 10/1515UTC

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and have since shown a very gradual downward trend. 100MeV commenced their downward tendency prior to this reporting period, and peaked at 0.13pfu at the start of the 24-hour window.

High energy electron flux (greater than 2MeV) observed by GOES16 has generally been Moderate, peaking at 937pfu at 10/1500UTC before the CME arrived and suppressed electrons back to background. The associated 24-hour fluence was below the Active threshold. No 24-hour integrated fluence figure is available for the period.

Four-Day Space Weather Forecast Summary

Solar Activity: The chances of further R3s reduce in the period as AR3842 rotates further onto the far side of the disk. R1s remain Likely given developments on the disc; their complexity; and up to four arrivals over the eastern limb to round out the current UTC working week.

Solar Wind / Geomagnetic Activity: The CME from the X1.8 flare and filament eruption is continuing to affect Earth, with an ongoing significant geomagnetic response. Solar wind speeds remain Strong and are expected to continue through the first part of 11 Oct, with a gradual easing trend later in the UTC day. Solar wind speeds should return to slightly elevated levels later day 2 or into day 3. There is also a potential coronal hole fast wind late day 3 (13 Oct), with any fast wind approaching 450km/s.

Initial G4-G5/Severe-Extreme Geomagnetic storms (Kp8-9) should begin to ease though day 1 (11 Oct) as the CME effects wane, becoming G1-G2/Minor-Moderate (Kp 5-6) by the end of the day. G1-G2/Minor-Moderate (Kp 5-6) are then likely early day 2 (12 Oct) with a slight chance of residual G3/Strong storms. Quiet-Active (Kp 1-4) activity is then expected days 3 and 4 (13-14) with a Slight Chance of G1 should either of the coronal holes' fast winds impinge on Earth.

Energetic Particles / Solar Radiation: The risk of S1/Minor storms remains for the first half of today (11 Oct) but falls thereafter, becoming near background levels with a slight chance of S1 from day 3 (13 Oct). High energy electron flux is now at background with any response post-CME expected to be largely limited initially. A rising Slight Chance of recovery of fluence may occur later in the UTC weekend before any possible fast winds arrive.

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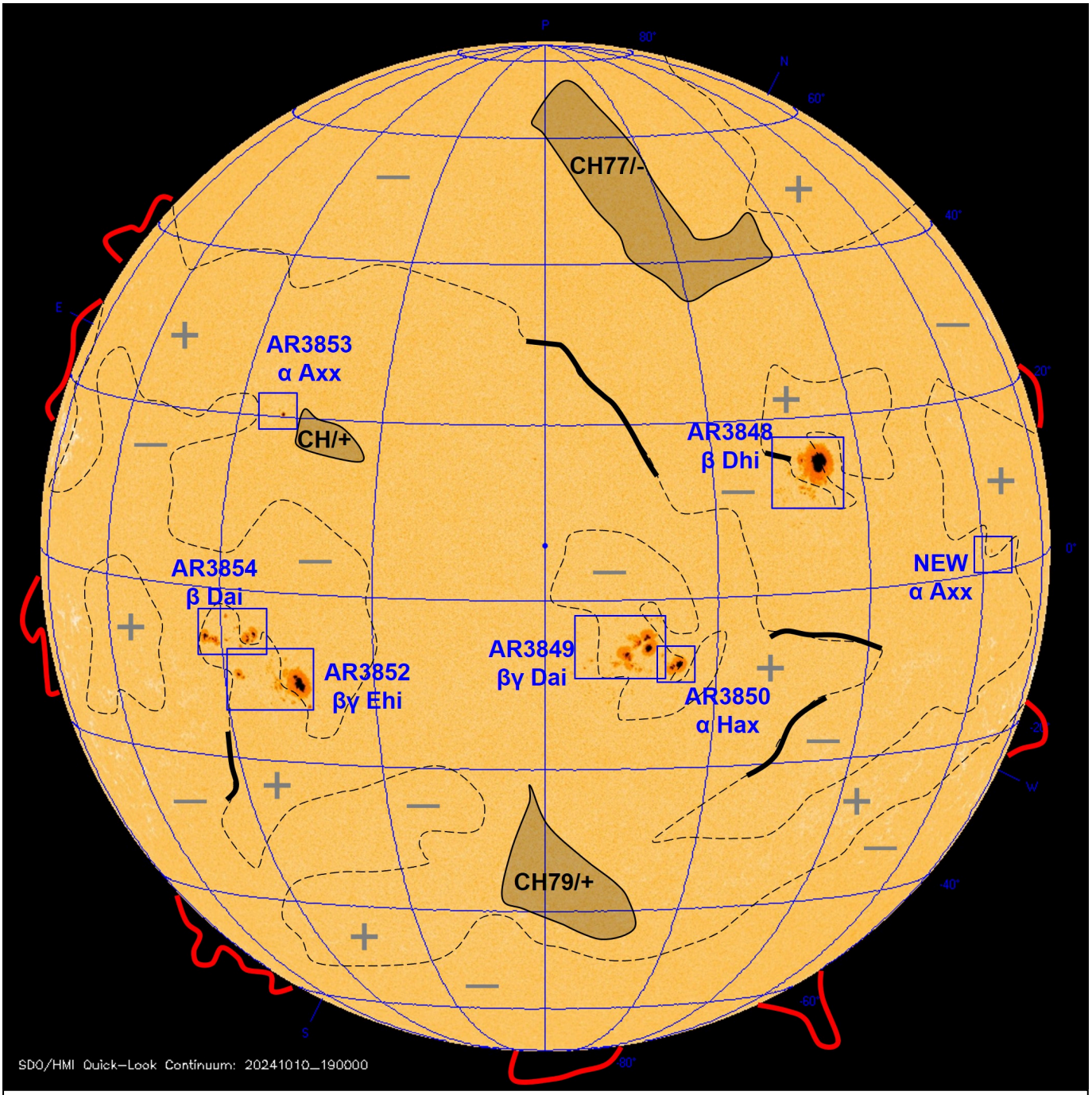
Figure 1: Solar synoptic map valid 10/1900 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME from the X1.8 flare and filament eruption is continuing to affect Earth, with an ongoing significant geomagnetic response, perhaps due to two arrivals within the magnetic cloud, one from the filament eruption and one from the X1.8 flare. Solar wind speeds remain Strong and are expected to continue through the first part of 11 Oct, with a gradual easing trend later in the UTC day. Solar wind speeds should return to slightly elevated levels later day 2 or into day 3.

There is also a potential coronal hole fast wind late day 3 (13 Oct). The presence of this is not assured, with Earth potentially 'threading the needle' between northern and southern hemisphere features. CH79/+ in the south has retreated pole-ward compared to last rotation and appears more tenuous, and therefore any connection with Earth is likely to be weak, with any fast wind approaching 450km/s. Alternatively, CH77/- also stands a chance of connecting around the same time, however its apparent greater intensity (versus CH79/+ from e.g. AIA211 imagery) will be mitigated against by its unfavoured polarity.

Initial G4-G5/Severe-Extreme Geomagnetic storms (Kp8-9) should begin to ease though day 1 (11 Oct) as the CME effects wane, becoming G1-G2/Minor-Moderate (Kp 5-6) by the end of the day. G1-G2/Minor-Moderate (Kp 5-6) are then likely early day 2 (12 Oct) with a slight chance of residual G3/Strong storms. Quiet-Active (Kp 1-4) activity is then expected days 3 and 4 (13-14) with a Slight Chance of G1 should either of the coronal holes' fast winds impinge on Earth.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	100	60	10	5
Strong	**G3**	Yes	95	20	1	1
Severe	**G4**	Yes	80	5	1	1
Extreme	**G5**	Yes	60	1	1	1

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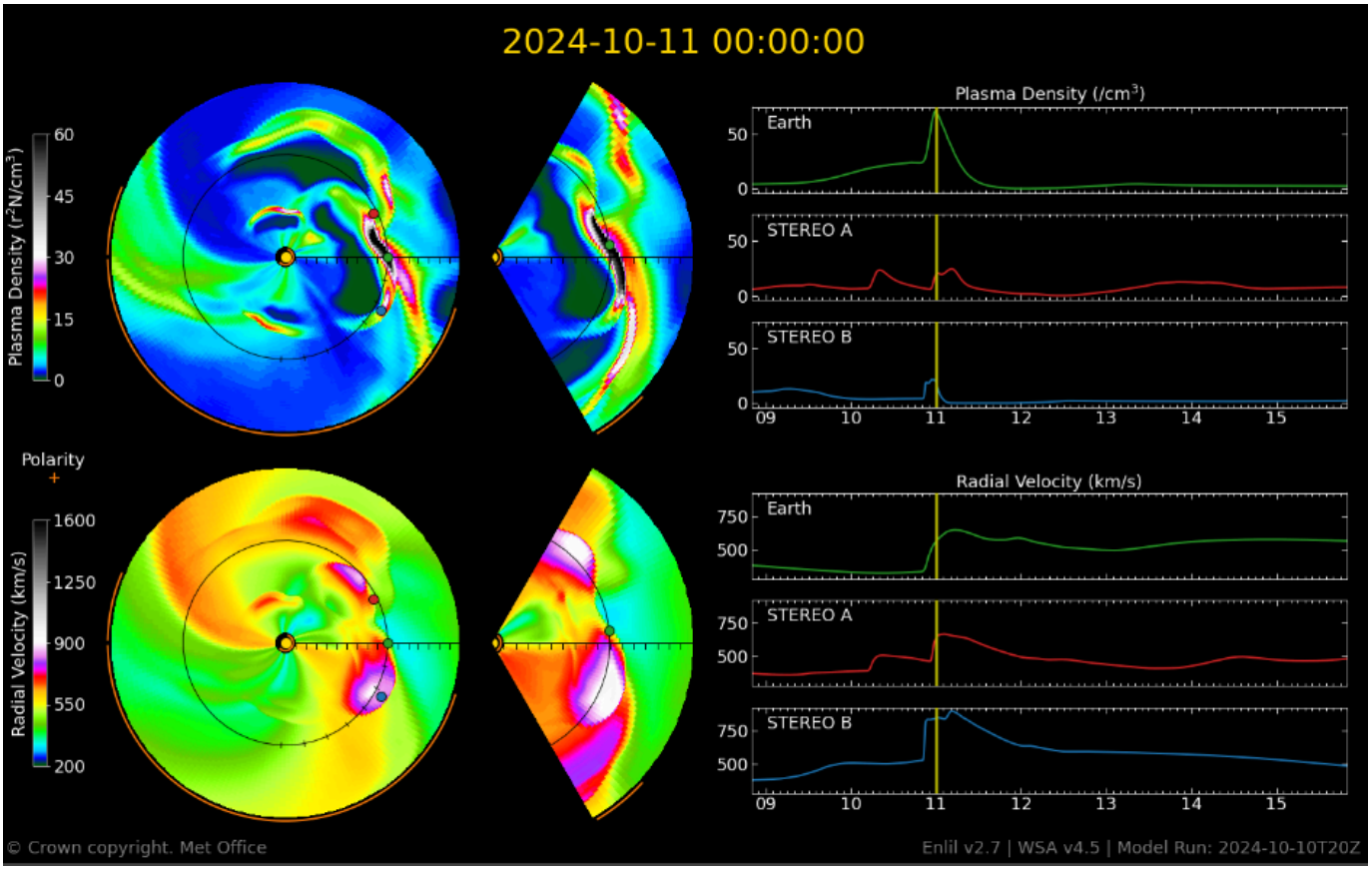
Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares

Activity has returned to Moderate levels, with an M3.0 from AR3842 peaking at 10/2230UTC.

There are six numbered sunspot regions on the visible disc. The largest region on the disk is AR3848 in the northwest, comprised of one main penumbral spot, with small negative spots and pores around the southern and southeastern periphery, though none are currently connected to the main positive leader, therefore losing it's delta magnetic complexity in recent hours. The next notable spot is the rapidly-growing AR3854 in the southeast, with a spreading tendency continuing and asymmetric penumbra around both the leading and trailing portions. AR3852, just ahead of AR3854, has shown a gradual spreading trend, now a medium length spot, with opposite polarity peripheral spots to the south of the negative leader allowing this region to have north-south magnetic sheer. AR3849, in the southwest near centre disc, showed little change, while AR3850, to its immediate west, has begun to lose penumbra around the leading and trailing peripheral spots, with a trend heading toward becoming a unipolar region. AR3853 in the northeast, and the new region in the northwest are both small and stable regions. Previously active AR3842 has now completely rotated beyond the southwest limb.

Moderate activity is likely to continue with a slight chance of isolated X-class flares. Risks are held higher than raw probabilities as flares from AR3842 may yet still feature as it rotates further around the far side of the disk. Otherwise, the risk of flares from on the Earth facing disk are spread largely evenly across the current larger spots. The risk of S-scale enhancements are greatly increased from raw values given the ongoing S2 proton storm, with a gradual easing trend now evident and expected to continue through the next 24 hours.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	60	60	60
Very Active	R3-R5 (X Class)	No	20	15	10	10

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Figure 3: 24 hour X-ray flux

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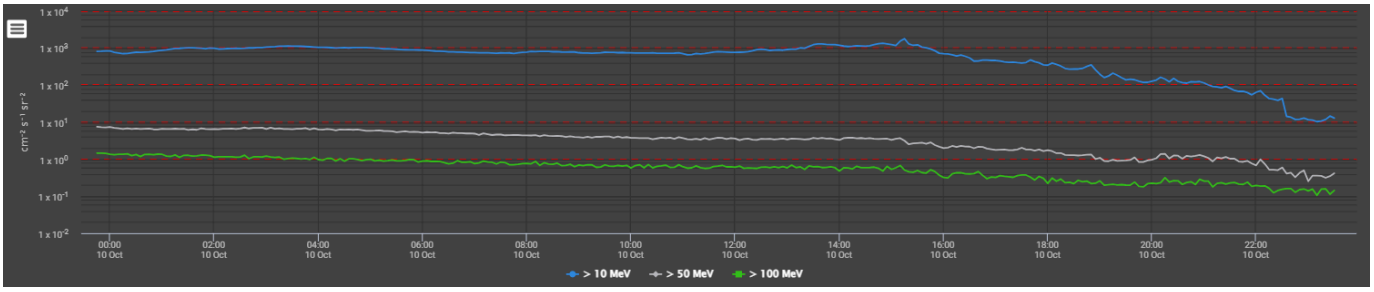
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is now falling to low S1 levels in wake of the combined X1.8 and filament eruption on 09 Oct from the vicinity of AR3848 in the northwestern quadrant.

The risk of S1/Minor storms remains for the first half of today (11 Oct) but falls thereafter, becoming near background levels with a slight chance of S1 from day 3 (13 Oct).

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	90	30	20	20
Very Active	**≥ S3 ***	Yes	10	5	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton trace at L1 (GOES 18).



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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) is currently at background levels after the 09 Oct CME arrival during the second half of 10 Oct. The CME will likely heavily compress the radiation belts for 11 and perhaps 12 Oct, with a diurnal moderate and high possible 12 or 13 Oct before any fast wind from CH79/+ (or perhaps CH77/-) take effect, should they arrive.

There is a rising Slight Chance of Active 24-hour integrated fluence, probably peaking later in the UTC weekend given the forecast described above. MOSWOC REFM is not considered useful in this situation given the utter dominance of a large CME early in its evolution, and the limited forecast horizon of 72 hours for REFM when considering any effects from the fast wind.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	10	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: Electron flux observations and MOSWOC REFM fluence forecast/recurrence.

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